

California Global Warming Solutions Act of 2006

## **Cement Technical Team**

**Focused Meeting to  
Discuss Initial Mandatory Greenhouse  
Gas Emissions Reporting Concepts**



March 13, 2007  
Sacramento, CA  
Cal/EPA Headquarters

## **Cement Technical Team Meeting Overview**

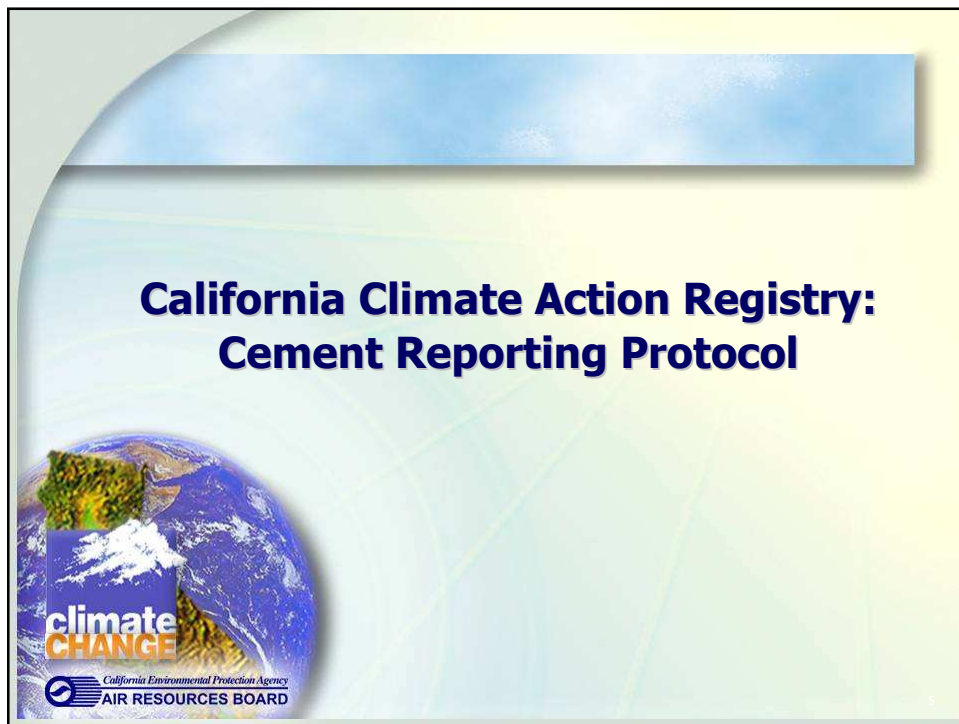
- Climate Change Reporting: AB 32
- California Climate Action Registry:  
Cement Reporting Protocol
- Initial Concepts for Mandatory Reporting for Cement
- GHG Emission Estimation Methods for Cement
- Current Inventory for Cement
- Cement GHG Emissions Verification
- Next Steps and Schedule

## **Climate Change Reporting: AB 32 Requirements**



### **AB 32 Statutory Requirements**

- Regulation by January 1, 2008
- Begin with sources contributing the most to statewide emissions
- Account for all electricity consumed
- Use Registry protocols
- Provide reporting tools



## California Climate Action Registry: Cement Protocol Development Process

- Developed draft protocol based on WBCSD clinker-based guidance
- Formed Review group (June 2005)
  - Review group provided feedback on draft guidance
- Registry held multiple group-wide conference calls allow for discussion on
  - The Registry
  - The draft protocols
- Public Workshop on November 15, 2005

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## California Climate Action Registry: Cement Reporting Protocol

- Adopts WBCSD approach for calculating CO<sub>2</sub> from clinker production
  - Clinker-based methodology
- Calculates **process-related CO<sub>2</sub>** emissions from
  - The amount of clinker produced plus
  - The amount of cement kiln dust (CKD) not recycled to the kiln
- Refers to the General Reporting Protocol (GRP) to calculate emissions from other sources

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## Comparison of Cement Protocols: CSI & Registry

### CSI Protocol

- Clinker Method
- Dust Calcination
- Organic Carbon (TOC) in Raw Materials
- Stationary Combustion
- Alternative Fossil Fuel
- Other GHGs
  - Not Quantified

### Registry Protocol

- Same as CSI Protocol
- Exceptions Below
  - Mobile Combustion from All Vehicles
  - CH<sub>4</sub> & N<sub>2</sub>O Emissions from Kiln Fuel Combustion



Comparison of the Registry's *draft* Cement Protocol and  
The Cement CO<sub>2</sub> Protocol from WBCSD

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## Initial Concepts for Mandatory Reporting



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## **Emission Sources to Report**

- Direct Process-Related Emissions
- Direct Emissions
- Indirect Emissions from Purchased Electricity Heat/Steam
- Efficiency Metric (Ton CO<sub>2</sub>/Ton Cement)

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## **Key Questions**

- Who is subject to reporting
- Organizational Boundaries
- Other Comments

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## Options for Cement GHG Emission Estimation Methods



## Direct Process CO<sub>2</sub> Emissions

### Clinker-Based Methodology

$$\text{Process CO}_2 \text{ emissions} = [(Cli) (EF_{Cli}) + (CKD) (EF_{CKD})]$$

Where:

**Cli** = Quantity of clinker produced

**EF<sub>Cli</sub>** = Clinker emission factor

**CKD** = Quantity CKD discarded

**EF<sub>CKD</sub>** = CKD emission factor

## Clinker-Based Methodology: Clinker Emission Factor

- $\text{CO}_2$ /mass clinker
  - Reflects the  $\text{CaCO}_3$  and  $\text{MgCO}_3$  contained in the raw materials and excludes non-carbonate CaO and MgO
  - Based on the percent of CaO and MgO in the clinker and
  - Adjusted to account for non-carbonate CaO and MgO.
- Steps:
  - Determine amount of clinker produced,
  - Determine CaO and MgO content of clinker
  - Subtract the non-carbonate sources CaO and MgO from the total amount of CaO and MgO
  - Multiply the remaining quantity of CaO and MgO by their respective stoichiometric ratios.

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## Direct Process Emissions: Data Collection

### Activity Data for Clinker-Based $\text{CO}_2$ Estimation Method

Clinker produced	Mass
CaO content of clinker	%
MgO content of clinker	%
Non-carbonate CaO	Mass
Non-carbonate MgO	Mass
Amount of discarded CKD not recycled to the kiln	Mass

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## Direct Process CO<sub>2</sub> Emissions

- Amount of Clinker Produced
  - Clinker-Based
- Carbonate Content of Process Input
  - Cement-Based
  - Kiln-Input – European Union Calculation Method

$$\text{CO}_2 \text{ emissions}_{\text{clinker}} = \sum \{ \text{Activity data} * \text{Emission factor} * \text{Conversion factor} \}$$

- Other Methodologies

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## Direct Process Emissions: Organic Carbon in Raw Materials

**CO<sub>2</sub> emissions from TOC in raw materials =**

$$(\text{TOC}_{\text{R.M.}}) (\text{R.M.}) (3.664)$$

**Where:**

**TOC<sub>R.M.</sub>** = Organic carbon content of raw material (%)

**R.M.** = The amount of raw material consumed (t/yr)

**3.664** = The CO<sub>2</sub> to C molar ratio

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## Stationary Emissions

- Non-mobile sources emitting GHGs from fuel consumption
  - Boilers, turbines, Internal combustion engines, flares, etc.
- Two methods:
  1. Measurement
    - Continuous Emission Monitoring System (CEMS) Reports
  2. Fuel Use calculation
    - Annual consumption

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## Mobile Emissions

- Non-fixed sources
  - autos, motorcycles, boats, airplanes, etc.
- Method 1: **Annual Fuel Consumption** (CO<sub>2</sub>)

*Example:*

10,000 gallons x 8.78 kg CO<sub>2</sub>/gallon = 87.81 metric tons CO<sub>2</sub>

- Method 2: **Annual mileage** (CO<sub>2</sub>)
- Method 2: **Annual mileage** (CH<sub>4</sub>, N<sub>2</sub>O)

For each vehicle:

- Identify vehicle type, fuel, model year and annual mileage to find average fuel efficiency ([www.fueleconomy.gov](http://www.fueleconomy.gov))
- Miles x (45% x city fuel efficiency)(55% x hwy fuel efficiency)
- Annual gallons x emission factor = Total CO<sub>2</sub>

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## Fugitive Emissions

- Majority of fugitive emissions are specific to industrial sectors or processes
- GRP Guidance for estimating fugitive hydrofluorocarbon (HFC) emissions from refrigeration systems

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## Indirect Emissions: Electricity Use

### **METHOD 1: Calculate Emissions**

1. Determine annual electricity usage purchased and consumed
2. Apply electricity emission factor
  1. CO<sub>2</sub> - eGRID subregion – see next slide
  2. CH<sub>4</sub>, N<sub>2</sub>O – state specific
3. Calculate total annual emissions (metric tons)
4. Convert non-CO<sub>2</sub> gases to CO<sub>2</sub> equivalent

#### *Example:*

50,000 kWh x 0.805 lbs CO<sub>2</sub>/kWh = 15.04 metric tons CO<sub>2</sub>

## Cement Manufacturing: Efficiency Metric

CO<sub>2</sub> Emissions per ton of cementious product =

Direct + Indirect CO<sub>2</sub>emissions from cement manufacturing

Own clinker consumed or added to stock	+	own clinker sold directly	+	gypsum, limestone, CKD & clinker substitutes consumed for blending	+	cement substitutes
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## Key Questions

- Facility Data
  - Collect data on quantity of clinker produced?
  - Percentages of raw feed material?
  - Collect data on cement kiln dust?
- Ability to Estimate Emissions
  - Difficulty generating estimates?
- Accuracy of Estimates
  - Emission factors representative?
- Estimation Methodologies
  - Multiple options or one approach?
  - Preference for one method over another?

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## Current Inventory for Cement



## Current GHG Inventory Estimate for Cement Manufacturing

- Combined Emissions:
  - 4.62 MMTCO<sub>2</sub> Eq. from calcination
  - 0.18 MMTCO<sub>2</sub> Eq. from natural gas combustion
- Total 4.80 MMTCO<sub>2</sub> Eq. in 1990**
- CO<sub>2</sub> emissions from combustion of coal associated with cement manufacture are included in separate category
  - ARB staff preliminary estimate: 2.5 MMTCO<sub>2</sub> Eq.



## **CEC's Cement Manufacturing Methodology**

- Process CO<sub>2</sub> emissions are based on California clinker production data
  - Assumption of percent lime of the clinker
  - Molecular weight ratio of carbon dioxide to lime
  - Cement Kiln Dust (CKD) correction factor
- Fuel combustion emissions of CO<sub>2</sub> are based on fuel use data from the CEC Energy Balance Report with emission factors from the IPCC.

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## **Data Sources**

- Clinker Production Data (USGS)
- Percent Lime factor (IPCC 2000)
- Cement Kiln Dust (CKD) correction factor (IPCC 2000)
- Fuel Use Data (CEC Energy Balance)

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## Cement GHG Emissions Verification



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## Verification

- Third party
- ARB audits
- Combination of methods
- Need to consider frequency, costs and scope

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## Next Steps and Schedule



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## Next Steps and Schedule

- Technical Team Meetings
- Public Workshop in May
- Staff Report in October
- Board Hearing in December

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**GHG Mandatory Reporting Website**  
<http://www.arb.ca.gov/cc/ccei/ccei.htm>

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**GHG Mandatory Reporting Website**  
<http://www.arb.ca.gov/cc/ccei/ccei.htm>